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h.	'	"	
12	52	45	Medium Mare Nubium.
12	55	28	Totus Schicardus videtur.
I	00	58	Medium Mare Fœcunditatis.
I	I	26	Totum Mare Nubium & Tranquillitatis.
I	4	15	Incipit emergere Mare Nectaris.
I	7	40	Totus Tycho.
I	12	40	Totum Mare Nectaris, & Fœcunditatis.
I	27	40	Finis totalis Eclipseos.
I	31	30	Extinguitur penumbra de Limbo Lunæ, nemine dubitante.

XLV. *A Letter to George Lewis Scot, Esq;
F. R. S. concerning the Number of People
in England; from the Reverend William
Brakenridge, D. D. Rector of St. Michael
Bassishaw, London, and F. R. S.*

Dear Sir,

Read Nov. 20, 1755. **H**AVING lately wrote to you my ob-
servations, concerning the number
of inhabitants in London and Westminster, this has
led me also to consider, whether there may not be
some way to compute nearly, the number of people
throughout England; and if it can be done, there
are many political uses that may be made of it, and
many conclusions that may be drawn, which may
prevent mistakes in Government, and that will tend
to promote the strength and riches of the Nation.
The subject is indeed intricate, and there cannot be
that

that accuracy in such calculations as might be desired; but I imagine we may come so near the truth, as is sufficient for any purpose to reason upon, or to be a foundation for any speculations in Policy. As you are a good judge of such computations, I presume to send you what I have done; and if I have your approbation, I shall be more satisfied that I am in the right; but, if I be mistaken in any particulars you will, I hope, make great allowance for the failure, when you consider the difficulties that occur.

There seems to me to be only two ways of discovering the number of people in England, where at present there are no Capitation Taxes; either by the number of *Houses*, or the quantity of *Bread* consumed. I shall consider both these methods of computing, so far as things are known to me; and the result from each of them being compared together, they will correct one another, from which at least the limits of the number may be nearly found. As to the first it is evident, that if the number of houses could be determined, it would then be very easy to compute nearly the number of people. For it might be easily known by trial, what number, at an average, could be allowed to each house, and from thence the whole number of people deduced. In my letter last year I have assigned six to a house in Town, which I found to be the nearest number, in some Parishes, by an account taken; but I think it is still more plain in the Country, that six is the number to be fixed on, where people do not go so much into single life, and where there are not so many Lodgers. For if we consider, that for every marriage there are
four

four births, at an average; as Dr. Derham, Major Graunt, and others have shewn, and which I have found to be true from the Registers both in the Town and Country; then consequently, allowing for deaths, there cannot be three children that survive, from every marriage to mature age, and indeed not much above two, as appears from Dr. Halley's Table of the probability of life. And therefore every family, where there are children, one with another, cannot consist of more than between four and five persons, besides servants or inmates; which shews plainly that families, where there are children, cannot be estimated at more than six to a house, and where there are no children, they cannot be reckoned more at an average.

The number then being six to be assumed, let us next consider what number of houses is to be supposed. That I might come at some certainty in this I lately applied to one of the Public Offices, where I thought they could very likely give me an account of them; and I there found, that before the year 1710, and near about that time, an account had been taken of all the houses throughout England and Wales, in order for some Assessment upon them; and the number then did amount to 729048. In which it may be supposed, that a number of Cottages were omitted, that might be improper for that Assessment; but I think there could not possibly be above one-fourth part of that number more: For surely the Surveyors, if they had any care of the Public Revenue, would never omit above one in Five. Let us therefore suppose, that there might be one-fourth part of that number more; and then those omitted will be about 182262, and the whole number of houses could not exceed 911310.

If

If now we take 911310 for the number, it is evident, if we allow six persons to a house at an average, according to what has been mentioned, the number of persons through England and Wales, before the year 1710, could not be above 5467860. And since that time, 45 years ago, by a method of computing which I shall presently shew, the increase could not be above 789558; and so the whole number of people now must be about 6257418; or six Millions, all ages included; for it must be remembered, that in our wars since 1710, there could not be fewer lost than 200000, which is to be deducted from that number.

As to the other way of determining this, by considering the quantity of *Bread* that is consumed, it may perhaps at first view appear more uncertain; but it will, I think, from some things that may be observed, at least help to ascertain the above number. For it is plain, if the quantity of *Wheat* that is produced in England could be known, it would then be very easy to make the computation, as it might be nearly discovered, by a little observation, what each person at an average might consume. But the great difficulty is to find out nearly the quantity of *Wheat*; and there seems to be no way at present of knowing it, but by considering what proportion it may have to the *Barley*; for the quantity of that is nearly known from the Malt-tax.

Now, if we compare the quantity of the *Barley* with that of the *Wheat* in England, it is evident, that there is at least as much ground sowed with the one as with the other. For there are vast tracts of land that will not bear good wheat, but are frequently sowed
with

with barley; and even those lands that will produce good wheat, they are often alternately sowed with it: The land that is rich and well manured, after one crop of wheat, it is usual to sow it with barley. And if this be admitted, that the quantity of land sowed with the one is equal to that sowed with the other, there must then be a much greater quantity of barley; because the same number of acres will produce much more of it, and generally in a greater proportion than Three to Two. These facts are so well known that I believe every reasonable Farmer, when he considers them together, will allow, that the barley cannot be in a less proportion to the wheat than Three to Two.

If then we allow, to make a calculation, that they are in this proportion, though I think, from what I have observed in the Country, the difference is greater, we shall then nearly find the quantity of wheat from the Malt-tax; because the general consumption of barley is in malt. To state this as exactly as we can, it must be remembered, that there are about 500000 quarters of wheat almost annually exported, as appears from the Bounty-money paid by the Government; and some of it is made use of in mechanical purposes at home, besides food. And on the other hand there is some barley exported, though nothing near to the quantity of wheat, and a great deal of it given to fatten Hogs; so that the barley exported, and what is given for the purpose of fattening, may be thought to be equal, or more than the wheat exported, together with what is used for mechanical purposes. Let us imagine that they are equal, for the error will not be great in this gross manner

manner of computing, and then the remaining quantity used in malt must be in a greater proportion to the remainder of the wheat used in food than Three to Two.

If then we assume this, that the barley used in malt is to the wheat used in food at home, as Three to Two, though I believe the malt is in a greater proportion to the wheat, we shall then be able to compute the quantity of each of them in this manner: The Malt-tax from the year 1747 to the year 1753 inclusive, amounted to the sum of 4,254813 *l.* of which the seventh part, the Tax for one year, is 607830 *l.* and as the Tax is four shillings upon every quarter of barley, it follows, that there are 3039150 quarters of barley consumed yearly in malt; and therefore, by what has been said above, that this quantity cannot be in a less proportion to the wheat than Three to Two, there must be 2026100 quarters of wheat consumed at home. Now, as it is known, and I have observed it in the country, that labouring healthy people, at an average, consume about one quarter of wheat in the year, which is about 512 pounds of flower, or one pound and six ounces in a day, we may allow that healthy and unhealthy, grown people and children, do not consume the half of that quantity, one with another. And therefore, that we may make the consumption of each person at an average, as small as can reasonably be imagined, we will suppose that three people, children included, do not consume more than one hearty labouring person, that is one quarter in the year, or each person about seven ounces in a day; and by this supposition, the above number of quarters of wheat 2026100, consumed at home,

will be sufficient for 6078300, or six millions of people. And this quantity of a quarter to three persons, though it appears too little, may be admitted, as in some of the northern counties they use some Oat-bread and Rye-bread; and every healthy person may, one with another, be allowed to consume this quantity at least.

From this calculation it seems to me to be evident, that there cannot be above six millions of people in England: For the barley is certainly not in a less proportion to the wheat than Three to Two. And the quantity of wheat exported, and used in mechanical purposes at home, is not much less than the barley used in fattening, together with what is exported. And therefore the quantity of wheat used in food at home cannot exceed 2026100 quarters, which, computed at any reasonable rate, will not be sufficient for more than six millions of people; because it must always be supposed that labouring persons, or those in lower life, who have no great variety of food, consume much more bread, or food of wheat, than others in a more wealthy condition; and seven ounces a day, at an average, is rather too little allowance. And as from the other method of computing from houses, we found the number to be about 6,257400, from which at least 200,000 is to be taken for those lost in our wars since 1710, or near that time; it appears that both these calculations confirm one another, and that the number of people may be considered at about six millions, or rather less. In which, according to Dr. Halley's rule, there will be about fifteen hundred thousand men able to carry arms.

The worthy Dr. Derham, from the computations of Mr. King, which I never saw, supposes there is about five millions and an half of people in England; to which, if we add the increase that may be since that time, the number will be near about what we have made them. But Sir William Petty has endeavoured to make them, in his time, no less than 7369000, by supposing them to be in proportion to the Assessment, then eleven times greater than that in the city of London. In which, with regard to the city, he was certainly mistaken, as I have shewn last year; for the number at that time, in 1682, was not much above 504000, and therefore eleven times that, *viz.* 5544000 must, according to his own hypothesis, be the number of people in England. And if we allow 1355000 to be the increase in about 73 years since that time, by the method I shall presently shew, the number could not be now, according to that assessment, above 6899000. From which we ought at least to subtract 400000, which may be justly allowed for loss in our wars since 1690; and the remainder 6,499000 is not half a million more than we have made them. But to compute the number of people from any pecuniary assessment that must arise from trade, circumstances, and valuation of land, seems to me to be a much more uncertain method than either of these I have used.

The people then being computed at six millions, or rather less, it appears that England is but thinly peopled. For not only the exportation of at least 400,000 quarters of wheat annually shews plainly, that we want people to consume it at home, and that we maintain in bread about a million of foreigners abroad:

but if we examine more particularly we shall find, that the Country is capable of supporting one-half more inhabitants, or nine millions. According to Mr. Templeman's survey, England contains 49450 square miles, that is 31,648,000 acres, because a square mile is equal to 640 acres. And if we suppose one-fifth of it waste ground, heaths, &c. there will remain about 25,300,000 acres of land proper to be cultivated. And as it can easily be made appear, that three acres, well manured, is sufficient for the maintenance of one person, I mean if a great number of acres are taken together, to produce the various necessaries of life in victuals and cloathing, then there will be maintenance in England for 8,430,000 people, children included; which, with the advantage of fishing, that the situation of the country gives, we may well allow that there is sufficient provision for nine millions of people, that is three millions more than we have at present. And this is only from the natural produce, without any of the advantages from trade, and the help of our Colonies in America, by which double the number might be maintained. The above allowance of three acres to each person, I think is too much; but some consideration must be had of the inclosures and pleasure-grounds, which those in higher life will always have.

But in Ireland the case is still worse: For if there is but a million of people, as is commonly supposed, and according to Mr. Templeman 27400 square miles, which is 17,536,000 acres, and one-fourth or more be supposed waste; then there will be at least 12,000,000 good acres. And consequently if four acres in that country be allowed sufficient, at an average,

average, for the maintenance of one person, Ireland, if duly cultivated, could maintain two millions more people than it has now, or three times its present number of inhabitants.

And in Scotland, if there be, as is said, but a million and an half of people, for at present I know no way to compute them, and 27700 square miles, or 17,728,000 acres, and one-third be supposed waste, which is not too much in that Country, then there will be 11,000,000 good acres; of which, if we suppose that five acres of that soil is not more than sufficient for each person, then there may be provision for 2,200,000 people, or more, with the advantages of fishing, that is 700000 more than there are at present. From all which it is plain, that if the land in both the British isles was duly cultivated, they might sustain about six millions more people than they do now; that is as many more people as England now contains. And this proportion of the number of people, to the quantity of provisions that may be raised for them, from the natural produce of the country, I think is of great importance to consider, as it has many useful consequences, some of which might be mentioned, if this was a proper place for political reflections.

And here, by the way, it may be observed, if we extend our thoughts to the whole Globe of the Earth, and compare the quantity of land with the number of people, we shall find, that it will maintain above twenty-six times the present number of mankind. As this has hitherto not been taken notice of, I shall briefly shew it. The circumference of the Earth, supposing it to be a sphere, is, according to the mea-
sures

fures of Messieurs Picard and Cassini, 123,249,600 Paris feet, or 131,630,572 English feet, which is 24930 English miles ; and the diameter is 7935 English miles. And then the whole surface of the globe, by Prop. 38. lib. 1. *Archim. de Sphæra & Cylindro*, is $24930 \times 7935 = 197,819,550$ square miles. And as the whole surface is to the quantity of land, near about 8 to 3, the land will then be 74,182,331 square miles ; of which, if we allow one-third to be waste ground, or unfit to produce the necessaries of life, we shall have 49,454,887 square miles, or $49,454,887 \times 640 = 31,651,127,680$ good acres. Now the number of mankind over the whole globe is computed by Sir W. Petty, and others, to be under 350,000,000 ; but we will suppose them 400,000,000, which is surely more than their number, that we may avoid any uncertainty in computation ; and then there will be 79 good acres to each person. From which it is evident, if the soil in England be considered as a medium between the poor lands in the northern Climates, and the very fertile in the southern, and three acres be here sufficient for one person, that the earth can maintain more than twenty-six times its present number of inhabitants. And if we imagine the land to be in a greater proportion to the surface than 3 to 8, and the number of mankind less than we have supposed, the produce of the earth will then be in a greater proportion to them. And hence it plainly appears, that the earth is in a very imperfect state with regard to the number of people. And that if births and burials are supposed nearly in the same proportion, all over the Globe as in England, it will be above 1000 years before the earth can be fully peopled.

peopled. From which it seems probable, that the origin of mankind is not more antient than is commonly believed.

But now, to return to our purpose, let us in the next place see what may be the annual increase of the people in England, that we may be able to judge of the future improvement of the Country. Dr. Derham, in his *Physico-Theology*, has shewn, from some observations communicated to him, that the number of births are annually to the burials through England in general as 1,12 to 1, though I should imagine the births, if there was an exact account taken, would be in a little greater proportion. From which, if we could know the number of the burials, the increase would be easily found. And in my Letter last year I have there made it appear, that within the bills of mortality there die about one in thirty, and in some very healthy places in the country about one in fifty, which seem to me to be the two extreme degrees of health in England; so that in many Towns, and in fenny or marshy lands, the degrees of health must be between these two. Let us now take the mean between them, which is one in forty, and this will be nearly, at an average, the degree of health through England, or perhaps Britain in general, as Sir William Petty has observed, and which will very well serve to make a calculation of the increase of the people. For then, if we suppose the whole number to be 6000000, the fortieth part of it, viz. 150000 will be the number of the dead yearly. And the births, from the proportion of 1 to 1,12, will be 168000; from which, if we take the number of dead, the remainder 18000 must be the annual increase;

crease; which indeed is very small, and I believe much diminished, by the emigration of great numbers to our colonies in America, and settlements elsewhere. or by our wars, and losses at sea. So that if it was not for the accession of Foreigners, and those who come from Scotland and Ireland, the increase would be very inconsiderable, if any at all; which by the way shews the reasonableness and good policy of encouraging Foreigners to settle among us. However, let us suppose the annual increase to be 18000, and it will be easy from thence to find in what time the number of the people may be double, or in any given proportion; not by dividing 6,000,000 by 18000, considering the annual increase as a constant quantity, which is the method Sir William Petty uses by mistake, or perhaps not knowing how to do it otherwise; but by making this annual increase continually to increase as the whole number does. Let us propose the question first in general, the number of people being unknown, which is this:

The proportion being given of the living to the dead in one year, and also the proportion of the births to the dead, the number of the people being unknown; to find in what time the people shall be in any given proportion, to what they are at present.

Suppose n to be the unknown number of the people at present; and let the living be to the dead, in one year, as l to 1 , and the dead to the births as 1 to b , the proportion given to what their number is at present as p to 1 , and the number of years required to be y .

It

It is plain then, that the dead at the end of the first year will be $\frac{n}{l}$, and the births $\frac{bn}{l}$, and the whole number of people must be $n + \frac{bn}{l} - \frac{n}{l}$. In like manner, at the end of the second year, the dead will be $\frac{ln + bn - n}{l^2}$, and the births $\frac{lbn + bbn - nb}{l^2}$, and the whole number of people must be $n + \frac{bn}{l} - \frac{n}{l} + \frac{lbn + bbn - nb}{l^2} + \frac{n - ln - bn}{l^2} = n \times \frac{l + b - 1 \times l + b - 1}{l^2}$. And so at the end of the

third year the number of people will be $n \times \frac{l + b - 1}{l^3}$.

From which at length it is evident by induction, that the number of people at the end of the required number of years will be $\frac{n \times l + b - 1}{l^y}$. But as the proportion is then to be as p to 1, we shall have $\frac{n \times l + b - 1}{l^y} = p n$, and from thence $l + b - 1 = p l^y$,

And because the logarithms of equal quantities must be equal, we shall have $y \times \log. l + b - 1 =$

$\log. p + y \times \log. l$, and also $y = \frac{\log. p}{\log. l + b - 1 - \log. l}$.

And therefore the number of years y is determined by the logarithms of known quantities when the people shall be in the given proportion of p to 1.

It may be observed that the quantity $\frac{n \times l + b - 1}{l^y}$

may be considered as the ordinate of the logarithmic curve, whose abscisse is the index y , and that the

ordinate passing through the beginning of the abscisse, where $y = 0$, must be equal to n .

If now it be required to know when the people shall be doubled; let us substitute in the above formula, in place of b , l , p , the respective numbers 1, 12, 40, 2, and it will be $y =$

$\frac{\log. 2}{\log. 40. + 1, 12 - 1 - \log. 40}$; and then the logarithms

being taken we shall have $y = \frac{0,3010300}{0,0013009} = 231$;

which shews, that, according to the present state of births and burials, the people could not be doubled in less than 231 years.

And by the same method it appears, changing the signs of $b - 1$, that 230 years ago, in the time of Henry the VIIIth, the number could not be above one-half of what it is now, that is about 3,000,000.

And so if we were to find, when the number of people in England would be increased to nine millions, which, by what has been said above, is near about the outmost that can be maintained, from the natural produce of the country; we should then have $p = \frac{3}{2} = 1, 5$, because nine millions is to the present number, as 3 to 2, and also $y =$

$\frac{\log. 1, 5}{\log. 40. + 1, 12 - 1 - \log. 40.} = \frac{0,1760913}{0,0013009} = 135$;

which shews, that at the present rate of births and burials, it must be 135 years before England can be fully peopled.

If we suppose, as Sir William Petty does, that the burials are to the births as 9 to 10, that is 1 to 1, 111, which is something less than that of Dr. Derham's proportion, and that one dies in 40 in a year; if we substitute

substitute these numbers in the formula, we shall then find the time of doubling to be 250 years. For

$$\text{then it will be } y = \frac{\log. 2}{\log. 40 + 1,111 - 1 - \log. 40} =$$

$$\frac{0,3010300}{0,0012035} = 250; \text{ which shews how far Sir William}$$

was mistaken, in his method of calculation, when he made the time to be 360 years.

After the same manner, the number of years being given, it will be easy to find the proportional increase. Suppose after 45 years. For then we should have $45 \times \log. \overline{l + b - 1} - 45 \times \log. l = \log. p$ which will give $45 \times 0,0013009 = \log. p$. and therefore $p = 1,1443$, from which if n be equal to 5,467,860, we have $p^n = 6,256,872$. So that it appears if there was 5,467,860 of people in England at the year 1710, when the above-mentioned survey was made, there is now 6250000; if there was none to be deducted upon the account of our wars, and emigrations to our Colonies since that time.

From what has been found above, that $\overline{l + b - 1}^y = p^y$, it is evident, that the ratio of the increase in any number of years may be determined, without the number of people being known, or their proportion to the annual increase; and also that any one of the quantities l, b, y, p , may be found, the others being known. But if the ratio of the number of people to the annual increase be known; and consequently the proportion, of the number in any one year, to the number next year known, we shall then have a very simple equation. For if we suppose the number of people in any one year, to be

to that number with the increase added in the next year, as 1 to r , we shall then have $n r^y = n p$, or $r^y = p$. And in like manner if the proportion of the number of people to their increase, in a given cycle of years, had only been known, and that cycle be c , we should then have $n r^c = n p$, or $r^c = p$.

From which formula it would be easy to calculate the numbers of mankind, in all ages through the world, if we suppose them to arise from a given number, and the rate of increase known, in any period of years. And this may sometimes be of use to discover the number in any age, that might be possible to reason upon, and to find out the truth of any hypothesis. But I shall not enter upon it farther, as such calculations are liable to great uncertainty, from the frequent and various devastations of mankind.

And thus I have endeavoured to discover the number of the people in England, and the rate of their increase, from the few things I had known, which I think are of such a nature, that I cannot be far mistaken. I have indeed made them fewer than they are commonly believed, but, if I am right, it will be so much the better, to be undeceived in a matter of such consequence. You will easily discern from your extensive knowledge where I have failed, which, as the subject is so difficult, I hope you will more readily excuse. And pray let me have your remarks, in the freest manner, on the whole, which will greatly oblige, Dear Sir,

Sion-College,
Nov. 19, 1755.

Your most faithful servant,

W^m. Brakenridge.

P. S.

P. S. I find some gentlemen have objected to my account last year, of the number of the people within the London bills of mortality, that the diminution of the burials may only be owing to an extraordinary degree of health, that may have been for the last ten years, and not to any decrease of the number of the living. But these gentlemen have not attended to what is there shewn in the Table, that the births are also greatly diminished, and that from the decrease of both together, it is concluded, that the people are fewer. For if greater health was the cause of the decrease of the burials, the births for that reason ought rather to be more. The truth is, the decrease of the people diminishes the practice of physic, which makes some of that profession imagine, that the times are more healthy.

XLVI. *An Attempt to explain two Roman Inscriptions, cut upon two Altars, which were dug up some time since at Bath. By John Ward, LL. D. Rhet. Prof. Gresh. and V. P. R. S.*

Read Dec. 11, 1755. THESE two inscriptions were found near the same time and place with that, which has been already published in the forty eighth volume of the *Philosophical Transactions* (1). The altars, which contain them, are now in the pos-

(1) *Par. I, Num. li.*